

Advanced Sensor Platform to Evaluate Manloads For Exploration Suit Architectures

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HAT: 6.2.a/b/c-E

TA: 7.3 human mobility systems

TRL: start 3 / current 5

ICA PROJECT OVERVIEW

Space suit manloads are defined as the outer bounds of force that the human occupant of a suit is able to exert onto the suit during motion. They are defined on a suit-component basis as a unit of maximum force that the suit component in question must withstand without failure. Existing legacy manloads requirements are specific to the suit architecture of the EMU and were developed in an iterative fashion; however, future exploration needs dictate a new suit architecture with bearings, load paths, and entry capability not previously used in any flight suit. No capability currently exists to easily evaluate manloads imparted by a suited occupant, which would be required to develop requirements for a flight-rated design. However, sensor technology has now progressed to the point where an easily-deployable, repeatable and flexible manloads measuring technique could be developed leveraging recent advances in sensor technology.

INNOVATION

This development positively impacts schedule, cost and safety risk associated with new suit exploration architectures. For a final flight design, a comprehensive and accurate man loads requirements set must be communicated to the contractor; failing that, a suit design which does not meet necessary manloads limits is prone to failure during testing or worse, during an EVA, which could cause catastrophic failure of the pressure garment posing risk to the crew. This work facilitates a viable means of developing manloads requirements using a range of human sizes & strengths.

OUTCOME / RESULTS

- Performed sensor market research
- Highlighted three viable options (primary, secondary, and flexible packaging option)
- Designed/fabricated custom bracket to evaluate primary option on a single suit axial
- Manned suited manload testing completed and general approach verified

PICTURE OF ICA DEVELOPED PROTOTYPE



KEY TECHNICAL OBSERVATIONS

Packaging within the available suit axial interfaces was the key driving criteria with respect to sensor selection and integration. The primary option (sensing clevis pin, LCP375, above, newly developed by Omega Engineering) was selected due to its low profile and ability to interface with a custom suit axial bracket. The secondary option was a subminiature load cell by Futek (LCM200). This may be ideal in areas of the suit where packaging prohibits use of a large pin, but would likely require a mechanical scissor mechanism to translate the force appropriately for capture. Lastly, in the most difficult packaging areas, a two-axis strain gauge may be employed directly on suit structure. For this ICA work, only the primary option was fully investigated. Forces measured at the upper arm were in line with expectations.

FUTURE WORK

- Extension of primary sensor option to all appropriate axial locations using custom brackets
- Strategic development of secondary and/or flexible packaging option for specific axial locations as deemed necessary
- Maturation of a multi-channel DAC interface to expedite data collection
- Development of test protocol to determine manloads requirements considering ranges of human anthropometry and strength



